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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/668,454	09/22/2003	Ta-Chung Wu	17620R-002600US	2352
20350	7590	11/02/2004	EXAMINER	
TOWNSEND AND TOWNSEND AND CREW, LLP TWO EMBARCADERO CENTER EIGHTH FLOOR SAN FRANCISCO, CA 94111-3834			NGUYEN, KHIEM D	
			ART UNIT	PAPER NUMBER
			2823	

DATE MAILED: 11/02/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/668,454

Applicant(s)

TA-CHUNG WU

Examiner

Khiem D Nguyen

Art Unit

2823

Am

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 16 August 2004.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-25 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-25 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 22 September 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

New Grounds of Rejection

Claim Objections

Claim 1 is objected to because of the following informalities: In claim 1, line 5, after “performing a”, delete “the”. Appropriate correction is required.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

1. Claims 1-4 and 6-10 are rejected under 35 U.S.C. 102(e) as being anticipated by the applicant's admitted prior art (AAPA) of this application.

In re claim 1, AAPA discloses a method of forming a bottom oxide layer 15 in a trench structure 13, the method comprising: (a) providing a semiconductor substrate 1 and forming a trench structure on said semiconductor substrate (Fig. 1(a));

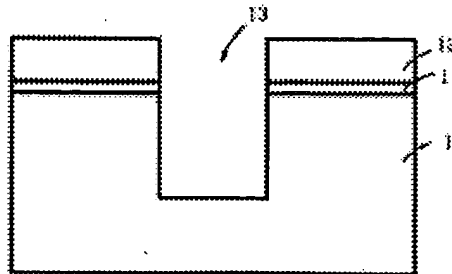


Fig. 1(a)
(PRIOR ART)

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(b) performing a the plasma-enhanced chemical vapor deposition (PECVD) process with tetraethylorthosilicate (TEOS) as a gas source to deposit an oxide layer 14 on the bottom **bt** and sidewall **sw** of the trench structure 13 and the semiconductor substrate 1, the oxide layer only partially filling the trench (Fig. 1(b)); and

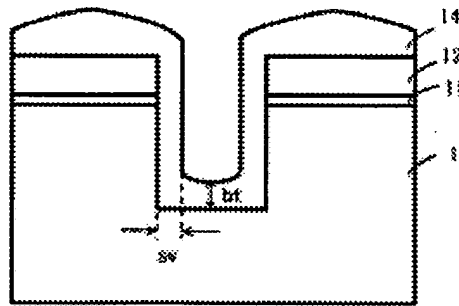


Fig. 1(b)
(PRIOR ART)

(c) removing the oxide layer 14 on the sidewall **sw** of the trench structure 13 substantially completely and the oxide layer on the bottom **bt** of said trench structure 13 partially to define a remaining oxide layer as the bottom oxide layer 15 (Fig. 1(c))
(Background of the Invention, pages 1-2).

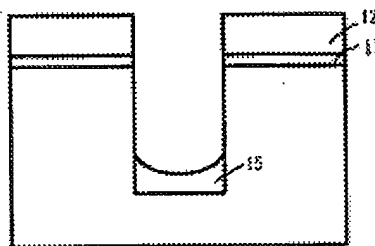


Fig. 1(c)
(PRIOR ART)

In re claim 2, AAPA discloses that the step (a) further comprises: (a1) forming a pad oxide layer 11 or 21 on the semiconductor substrate 1 or 2; (a2) forming a silicon nitride layer 12 or 22 on said pad oxide layer; and (a3) removing the silicon nitride layer, the pad oxide layer and the semiconductor substrate partially to form the trench structure 13 or 23 (Specification, page 1, paragraph [0003] and Fig. 1(a)).

In re claim 3, AAPA discloses that the step (a3) is performed by a photolithography and dry-etching process (Specification, page 1, paragraph [0003] and Fig. 1(a)).

In re claim 4, AAPA discloses that the trench structure has an aspect ratio between about 3.0 and about 4.0 (Figs. 1(a)-1(c)).

In re claim 6, AAPA discloses that a ratio of a thickness of the oxide layer 14 or 24 deposited on the bottom of the trench structure 13 or 23 to a thickness of the oxide layer deposited on the sidewall sw of the trench structure 13 or 23 is between about 1.5 and about 2.3 (Figs. 1(b) and 2(b)).

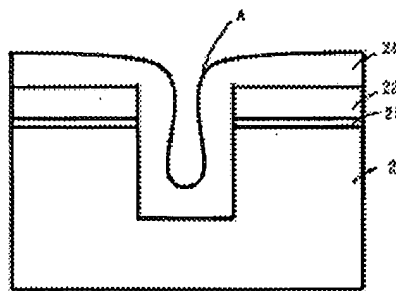


Fig. 2(b)
(PRIOR ART)

In re claim 7, AAPA discloses that the step (c) is performed by a wet-etching process (Specification, page 2, paragraph [0005] and Fig. 2(d)).

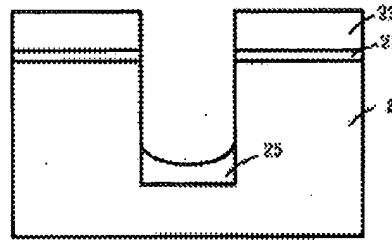


Fig. 2(d)
(PRIOR ART)

In re claim 8, AAPA discloses that an etching selectivity of the oxide layer **14** or **24** on the sidewall **sw** of the trench structure **13** or **23** to the oxide layer on the bottom **bt** of the trench structure is between about 2.5 and about 3 (Specification, pages 1-2 and (Figs. 1(a)-2(d)).

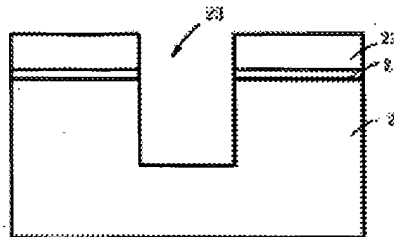


Fig. 2(a)
(PRIOR ART)

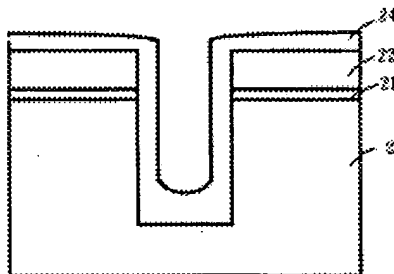


Fig. 2(c)
(PRIOR ART)

In re claim 9, AAPA discloses wherein after the step (c), the steps of depositing and removing the oxide layer **14** or **24** are repeated in sequence for allowing the bottom

oxide layer **15** or **25** to reach a required thickness (Specification, pages 1-2 and (Figs. 1(a)-2(d)).

In re claim 10, AAPA discloses wherein the oxide layer **14** or **24** comprises a silicon oxide layer (Specification, page 1, paragraph [0003] and page 2, paragraph [0005]).

2. Claims 11-14 and 16-20 are rejected under 35 U.S.C. 102(e) as being anticipated by the applicant's admitted prior art (AAPA) of this application.

In re claim 11, AAPA discloses a method of fabricating a trench-type power MOSFET, the method comprising: (a) providing a semiconductor substrate **1** or **2** and forming a trench structure **13** or **23** on the semiconductor substrate (Figs. 1(a) and 2(b)); (b) performing the plasma-enhanced chemical vapor deposition (PECVD) process with tetraethylorthosilicate (TEOS) as a gas source to deposit an oxide layer on the bottom bt and sidewall sw of the trench structure and the semiconductor substrate, the oxide layer only partially filling the trench (Figs. 1(b) and 2(b)); and (c) removing the oxide layer on the sidewall sw of the trench structure **13** or **23** substantially completely and the oxide layer on the bottom bt of the trench structure partially to define the remaining oxide layer as the bottom oxide layer **15** or **25** (Figs. 1(c) and 2(d)); and forming the trench-type power MOSFET device in the trench structure (Specification, pages 1-2).

In re claim 12, AAPA discloses wherein the step (a) further comprises: (a1) forming a pad oxide layer **11** or **21** on the semiconductor substrate **1** or **2**; (a2) forming a silicon nitride layer **12** or **22** on the pad oxide layer; and (a3) removing the silicon nitride

layer, the pad oxide layer and the semiconductor substrate partially to form the trench structure **13** or **23** (Specification, pages 1-2 and Figs. 1(a) and 2(a)).

In re claim 13, **AAPA** discloses wherein the step (a3) is performed by a photolithography and dry-etching process (Specification, page 1, paragraph [0003] and Fig. 1(a)).

In re claim 14, **AAPA** discloses that the trench structure has an aspect ratio between about 3.0 and about 4.0 (Figs. 1(a)-1(c)).

In re claim 16, **AAPA** discloses that a ratio of a thickness of the oxide layer **14** or **24** deposited on the bottom of the trench structure **13** or **23** to a thickness of the oxide layer deposited on the sidewall sw of the trench structure **13** or **23** is between about 1.5 and about 2.3 (Figs. 1(b) and 2(b)).

In re claim 17, **AAPA** discloses that the step (c) is performed by a wet-etching process (Specification, page 2, paragraph [0005] and Fig. 2(d)).

In re claim 18, **AAPA** discloses that an etching selectivity of the oxide layer **14** or **24** on the sidewall sw of the trench structure **13** or **23** to the oxide layer on the bottom bt of the trench structure is between about 2.5 and about 3 (Specification, pages 1-2 and (Figs. 1(a)-2(d)).

In re claim 19, **AAPA** discloses that between the steps of (c) and (d), the steps of depositing and removing the oxide layer **14** or **24** are repeated in sequence for allowing the bottom oxide layer **15** or **25** to reach a required thickness (Specification, pages 1-2 and (Figs. 1(a)-2(d)).

In re claim 20, AAPA discloses wherein the oxide layer **14** or **24** comprises a silicon oxide layer (Specification, page 1, paragraph [0003] and page 2, paragraph [0005]).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 5, 15, 21-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over the applicant's admitted prior art (AAPA) of this application.

In re claim 21, AAPA discloses a method of forming a bottom oxide layer in a trench structure, the method comprising: (a) providing a substrate **1** or **2** including a trench **13** or **23** having a bottom **bt** and a sidewall **sw** (Figs. 1(a) and 2(b)); depositing an oxide layer **14** or **24** on the bottom and sidewall of the trench by plasma-enhanced chemical vapor deposition (PECVD) process with tetraethylorthosilicate (TEOS) as a gas source, the oxide layer only partially filling the trench (Figs. 1(b) and 2(b)); and (c) removing the oxide layer on the sidewall **sw** of the trench **13** or **23** substantially completely and the oxide layer on the bottom **bt** of the trench partially to form a remaining oxide layer as the bottom oxide layer **15** or **25** on the bottom of the trench (Figs. 1(c) and 2(d)) (Specification, pages 1-2).

In re claims 5, 15, and 21, AAPA does not explicitly disclose that the plasma-enhanced chemical vapor deposition (PECVD) process is performed at a temperature of

about 440°C to about 520°C. However, there is no evidence indicating the temperature range is critical and it has been held that it is not inventive to discover the optimum or workable range of a result-effective variable within given prior art conditions by routine experimentation. See MPEP § 2144.05. Note that the specification contains no disclosure of either the critical nature of the claimed dimensions of any unexpected results arising there from. Where patentability is aid to be based upon particular chosen dimensions or upon another variable recited in a claim, the Applicant must show that the chosen dimensions are critical. In re Woodruff, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

In re claim 22, AAPA that the oxide layer **14** or **24** is removed by a wet-etching process having a higher etching selectivity of the oxide layer on the sidewall sw of the trench **13** or **23** to the oxide layer on the bottom bt of the trench (Specification, page 2, paragraph [0005] and Fig. 2(d)).

In re claim 23, AAPA discloses that the etching selectivity of the oxide layer **14** or **24** on the sidewall sw of the trench **13** or **23** to the oxide layer on the bottom bt of the trench is between about 2.5 and about 3 (Specification, pages 1-2 and (Figs. 1(a)-2(d)).

In re claim 24, AAPA discloses that the deposited oxide layer **14** or **24** has a ratio of thickness on the bottom of the trench **13** or **23** to thickness on the sidewall sw of the trench of higher than about 1.5 (Figs. 1(b) and 2(b)).

In re claim 25, AAPA discloses that the deposited oxide layer **14** or **24** has a ratio of thickness on the bottom of the trench **13** or **23** to thickness on the sidewall sw of the trench of lower than about 2.3 (Figs. 1(b) and 2(b)).

Response to Applicant's Arguments and Amendment

Applicant's arguments with respect to claims 1-25 have been considered but are moot in view of the new ground(s) of rejection.

Applicants contend that Bhakta et al. (U.S. Pub. 2002/001817) herein known as Bhakta does not teach or suggest performing a plasma-enhanced chemical vapor deposition (PECVD) process with tetraethylorthosilicate (TEOS) as a gas source to deposit an oxide layer on the bottom and sidewall of the trench structure and the semiconductor substrate, the oxide layer only partially filling the trench; and removing the oxide layer on the sidewall of the trench structure substantially completely and the oxide layer on the bottom of the trench structure partially to define a remaining oxide layer as the bottom oxide layer.

In response to Applicants' contention that Bhakta does not teach or suggest performing a plasma-enhanced chemical vapor deposition (PECVD) process with tetraethylorthosilicate (TEOS) as a gas source to deposit an oxide layer on the bottom and sidewall of the trench structure and the semiconductor substrate wherein the oxide layer only partially filling the trench, Examiner respectfully disagrees. Since Applicants' amendment necessitated the new ground(s) of rejection presented in this Office action, Applicants' argument is moot.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP §

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706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Khiem D Nguyen whose telephone number is (571) 272-1865. The examiner can normally be reached on Monday-Friday (8:00 AM - 5:00 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on (571) 272-1855. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

October 28th, 2004

A handwritten signature in black ink, appearing to read 'W. David Coleman', enclosed within a hand-drawn oval border.

**W. DAVID COLEMAN
PRIMARY EXAMINER**